

CLAIMS

1. An ozone processing apparatus that processes a process object by using ozone gas, comprising:

a processing part having a processing space adapted to contain a process object therein;

an ozone generator adapted to generate ozone gas from an oxygen-containing gas through an electric discharge;

an ozone supply line adapted to supply the ozone gas generated by the ozone generator into the processing space of the processing part;

a first steam generator adapted to generate water vapor;

a first steam supply line connected to the ozone supply line to supply the water vapor generated by the first steam generator into the ozone supply line; and

a metal trap arranged in the ozone supply line at a portion thereof downstream of a joint between the ozone supply line and the first steam supply line, the metal trap containing an adsorbent composed of a silicon-containing material.

2. The ozone processing apparatus according to claim 1, wherein the adsorbent is composed of pure silicon or SiO_2 .

3. The ozone processing apparatus according to claim 1, wherein the metal trap comprises a container containing plural chips composed of the silicon-containing material.

4. The ozone processing apparatus according to claim 1, further comprising:

a cooler arranged in the ozone supply line at a portion thereof downstream of the metal trap to cool a mixed fluid containing the ozone gas and the water vapor; and

a gas-liquid separator arranged in the ozone supply line at a portion thereof downstream of the cooler to separate the ozone gas contained in the mixed fluid cooled by the cooler from condensed water generated by cooling the water vapor.

5. The ozone processing apparatus according to claim 1, further comprising:

- a second steam generator adapted to generate water vapor;

- a second steam supply line connected to the ozone supply line at a portion thereof upstream of the joint between the ozone supply line and the first steam supply line to supply the water vapor generated by the second steam generator into the ozone supply line;

- a first cooler arranged in the ozone supply line at a portion thereof upstream of the joint between the ozone supply line and the first steam supply line and downstream of a joint between the ozone supply line and the second steam supply line to cool a mixed fluid containing the ozone gas and the water vapor; and

- a first gas-liquid separator arranged in the ozone supply line at a portion thereof upstream of the joint between the ozone supply line and the first steam supply line and downstream of the first cooler to separate the ozone gas contained in the mixed fluid cooled by the first cooler from condensed water generated by cooling the water vapor,

whereby the ozone gas separated by the first gas-liquid separator is mixed to the water vapor generated by the first steam generator, and is fed to the metal trap.

6. The ozone processing apparatus according to claim 5, further comprising:

- a second cooler arranged in the ozone supply line at a portion thereof downstream of the metal trap to cool the mixed fluid containing the ozone gas and the water vapor; and

- a second gas-liquid separator arranged in the ozone supply line at a portion thereof downstream of the second cooler to separate the ozone gas contained in the mixed fluid cooled by the second cooler from condensed water generated by cooling the water vapor.

7. An ozone processing apparatus that processes a process object by using ozone gas, comprising:

- a processing part having a processing space adapted to contain a process object therein;

- an ozone generator adapted to generate ozone gas from an oxygen-containing gas through an electric discharge;

- an ozone supply line adapted to supply the ozone gas generated by the ozone generator into the processing space of the processing part;

- a first steam generator adapted to generate water vapor;

- a first steam supply line connected to the ozone supply line to supply the water vapor generated by the first steam generator into the ozone supply line;

- a first cooler arranged in the ozone supply line at a portion thereof downstream of a joint between the ozone supply line and the first steam supply line to cool a mixed fluid containing the ozone gas and the water vapor; and

- a first gas-liquid separator arranged in the ozone supply line at a portion thereof downstream of the first cooler to separate the ozone gas contained in the mixed fluid cooled by the first cooler from condensed water generated by cooling the water vapor.

8. The ozone processing apparatus according to claim 7, further comprising:

- a second steam generator adapted to generate water vapor;

- a second steam supply line connected to the ozone supply line at a portion thereof downstream of the first cooler to supply the water vapor generated by the second steam generator into the ozone supply line; and

- a second cooler arranged in the ozone supply line at a portion thereof downstream of the joint between the ozone supply line and the second steam supply line to cool the mixed fluid containing the ozone gas and the water vapor.

9. The ozone processing apparatus according to claim 7, wherein the first gas-liquid separator comprises a tank holding water therein, whereby, when the condensed water and the ozone gas pass through the water in the tank, the condensed water is mixed to the water in the tank to be separated from the ozone gas.

10. A method of processing a process object contained in a processing space with ozone, comprising:

- a step of generating ozone gas through an electric discharge;

- a step of mixing water vapor with the ozone gas;

- a step of bringing a mixed fluid containing the ozone gas and the water vapor into contact with an adsorbent composed of a silicon-containing material, thereby allowing the adsorbent to adsorb a metal contained in the ozone gas to be removed therefrom; and

- a step of supplying the ozone gas, from which the metal has been removed, into the processing space, thereby processing the process object.

11. The method according to claim 10, further comprising:

- a step of cooling the mixed fluid after it contacts the adsorbent, thereby dissolving impurities contained in the ozone gas into condensed water generated by cooling the water vapor; and

- a step of separating the ozone gas from the condensed water.

12. The method according to claim 10, further comprising additional steps which are performed after the step of mixing water vapor with the ozone gas and before the step of bringing the mixed fluid containing the ozone gas and the water vapor into contact with the adsorbent composed of the silicon-containing material, said additional steps including:

- a step of cooling the mixed fluid, thereby dissolving impurities contained in the ozone gas into condensed water generated by cooling the water vapor;

- a step of separating the ozone gas from the condensed water; and

- a step of mixing water vapor again with the ozone gas thus separated.

13. A method of processing a process object contained in a processing space with ozone, comprising:

- a step of generating ozone gas through an electric discharge;

- a step of mixing water vapor with the ozone gas;

- a step of cooling a mixed fluid containing the ozone and the water vapor, thereby dissolving impurities contained in the ozone gas into condensed water generated by cooling the water vapor;

- a step of separating the ozone gas from the condensed water; and

- a step of supplying the ozone gas thus separated into the processing space, thereby processing the process object.

14. The method according to claim 13, wherein the step of mixing water vapor with the ozone gas and the step of cooling the mixed fluid containing the ozone gas and the water vapor are performed repeatedly for plural times.

15. The method according to claim 13, wherein the step of separating the ozone gas from the condensed water is performed by passing the ozone gas and the condensed water through water.